# PhysicsTutor

Interference

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# Problem:

- One of the mirrors of a Michelson interferometer is moved a distance of 2.0 mm. Meanwhile, the interference intensity moves through 7,000 dark fringes.
- What is the wavelength of the light?

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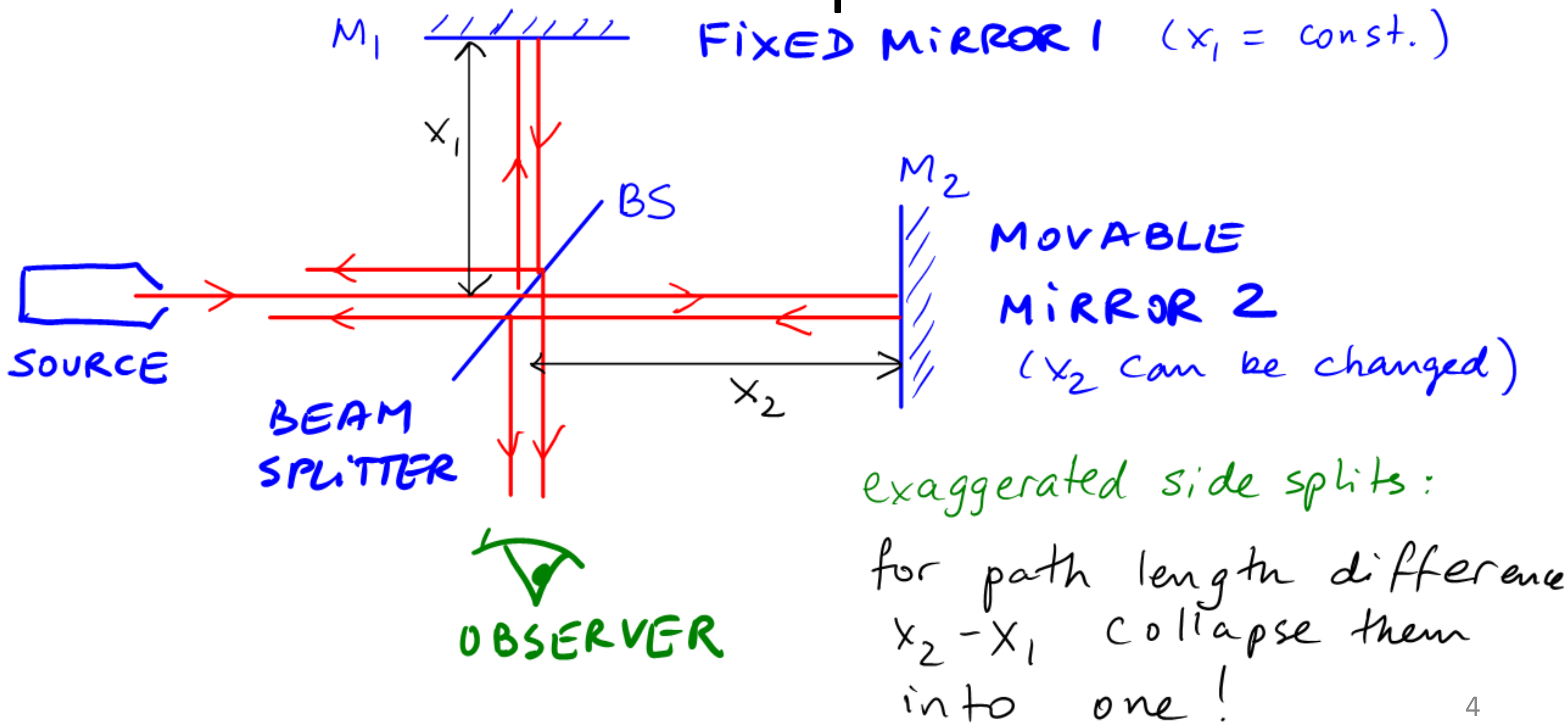

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- The number of phase jumps is the same for recombining beams.

beam 1 at BS and M 1

beam 2 at M 2 and BS

# Relevant ideas:

- Beams are split several times: the beam from the source is split in two, the returning beams from each mirror are also split.
- The number of phase jumps is the same for recombining beams.
- Find the path length difference. Ignore the details about the glass beam splitter (front surface versus back surface reflections).

# Equations associated with ideas:

$$E_{1/2}(x,t) = E_0 \sin\left(\omega t - \frac{2\pi}{\lambda} x\right)$$

to be combined at same time $t$ in the same place, but beam 2 accumulated more phase if $x_2 > x_1$:

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

where $\Delta x = 2(x_2 - x_1)$ ; $\lambda = \lambda_{air}$

$\lambda_{air} = \lambda_{vac}/n_{air}$ $\quad n_{air} \approx 1$

$$\Delta\phi = (2m-1)\pi$$

$m = 1, 2, \ldots$

destructive interference condition
crest meets through → dark

$m = 7000 \quad \hat{=} \quad x_2 - x_1 = 2.0\text{ mm} = \frac{\Delta x}{2}$ !

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- Same arrival time for both paths: find the accumulated phase difference (PD) in space from the optical path length difference.
- Equate the PD to an odd-integer multiple of $\pi$ for destructive interference.
- Use the order m=7000 to find $\lambda$.

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- $\lambda = 0.571\ \mu m \rightarrow 570\ nm \rightarrow$ yellow light ✓

Our calculation was based upon the path length difference between arms 1 and 2. The problem did not state that the path length was the same initially (constructive interference), but fringes appear/disappear proportional to the change in path length.